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ORDOVICIAN STRATIGRAPHY OF THE FLORENTINE SYNCLINORIUM, SOUTHWEST TASMANIA.

by K.D. Corbett
Department of Mines, Hobart, formerly University of Tasmania

and M.R. Banks
Department of Geology, University of Tasmania

ABSTRACT

The Florentine Synclinorium constitutes the type area of the Ordovician Junee Group in Tasmania, and the group is herein re-defined according to the formations present in this area. The base on the western side is formed by the Reeds Conglomerate, a unit of siliceous fanglomerate up to 1,560 m thick lying conformably above a thick Upper Cambrian sequence on the Denison Range. The laterally-equivalent sandstone unit on the southeastern side is also given formation status (Tim Shea Sandstone). The overlying sequence of marine sandstone and siltstone is designated the Florentine Valley Formation, and is of Late Tremadocian-Arenigian age. A sub-unit of siltstone and limestone occurs in the middle part of the formation in some areas, but is not given formal status pending further mapping.

The "Gordon Limestone", subdivided into three formations, becomes the Gordon Limestone Sub-Group. The basal Karmberg Limestone, of Upper Canadian -? Chazyan age, includes a mappable chert-rich unit which forms chert-covered ridges and is designated Wherretts Chert Member. The Cashions Creek Limestone, corresponding to the "*Maclurites-Girvanella* zone" of earlier reports, succeeds the Karmberg Limestone. Above this, and forming the bulk of the sequence, is the Benjamin Limestone, consisting of three members, viz. Lower Limestone Member, Lords Siltstone Member, Upper Limestone Member. A characteristic coral fauna with *Favosites* and cateniporines occurs near the top of the latter member, and includes conodonts which suggest an age not younger than Maysvillian.

Above the limestone sequence and transitional with the overlying Eldon Group sandstone is a unit of siltstone and fine sandstone designated Westfield Beds. These contain a fauna correlated with the Richmondian, and the fauna in the overlying sandstone also appears to be Late Ordovician.

INTRODUCTION

This paper presents details of the stratigraphy of the Ordovician succession in the Florentine Valley - Adamsfield area, regarded as the type area of the Junee Group in Tasmania. The Gordon Limestone sequence is subdivided for the first time, into three formations, and a new unit above the limestone, the Westfield Beds, is introduced. Some new palaeontological data are given, including work which indicates that the top of the limestone sequence is probably of Maysvillian age. It is hoped that the sequence established will provide a good basis for detailed correlation throughout the State.

The work is based mainly on mapping done by the senior author in the Florentine Valley in 1962-63 for a B.Sc. Honours project at the University of Tasmania, and on later mapping (partly reconnaissance) of the remainder of the area as part of a Ph.D. project in 1966-69. The sections on palaeontology have been written by Banks, with a contribution on conodonts by Mr. C.F. Burrett. The palaeontological work must be regarded as mainly of a reconnaissance nature and determinations of the macrofossils as preliminary. Many of the forms, especially of brachiopods and trilobites, probably belong to new genera and the names given suggest the closest affinities only. Excit-

ing palaeontological work in stratigraphically well controlled collections is indicated for the future. Fossil collections are held at the Geology Department, University of Tasmania. The work has been supported by research funds from the University of Tasmania and a grant from the Australian Research Grants Committee. Australian Newsprint Mills Ltd. provided accommodation and assisted with transport and we are indebted to Mr. D. Kitchener and Mr. D. Frankcombe and their staff for many courtesies.

GEOLOGICAL SETTING

The Florentine Synclinorium (Corbett 1970) is the name given to the large synclinal structure occupied by Ordovician and Siluro-Devonian rocks in the Florentine Valley area, its deepest part underlying the Tiger and Gordon Ranges. Its western and southern limits are defined by the ridges of Lower Ordovician conglomerate and sandstone extending from Battlement Hills in the north to the Saw Back Range in the south and thence east to Tim Shea (fig. 1). The northern and eastern margins are overlapped by, or faulted against sub-horizontal Permo-Triassic sediments and Jurassic dolerite, along an escarpment extending from Wylds Craig along the Misery Range to Mt. Field West and Florentine Peak.

The synclinorium lies at the eastern margin of a large basement block of metamorphosed Precambrian quartzites and schists known as the Tyennan Geanticline, and is one of a series of large synclinal structures fringing this geanticline and produced during the Middle Devonian Tabberabberan Orogeny. A separate basement block, composed mainly of unmetamorphosed Precambrian dolomite, quartzite and argillite and called the Jubilee Block (Corbett 1970), plunges north under the southern end of the synclinorium.

A series of broad open folds comprise the synclinorium, the major one being the Tiger Syncline, which has a thick core of Siluro-Devonian rocks. Flanking this to the east are the Tim Shea Anticline, Westfield Syncline and Parker Anticline, and to the west the Adamsfield Anticline and Eve Creek Syncline. Most of the folds are oversteepened from the west, with dips up to nearly vertical, and have axes which are either subhorizontal or plunge gently north. The Westfield Syncline has a shallow core of Eldon Group rocks at its southern end. The Misery Range Fault (Jennings 1955), which forms the contact with the younger rocks to the east in some places, possibly follows the southerly continuation of the axis of the Parker Anticline.

The synclinorium overlaps to a large extent an earlier eugeosynclinal trough of Cambrian rocks, called the Adamsfield Trough (Corbett 1970). Part of this trough is exposed between the western edge of the synclinorium and the adjacent Tyennan Geanticline, and in a smaller area against the Jubilee Block near Mt. Mueller. The Cambrian rocks consist of two main groups, viz. (i) an older, apparently unfossiliferous, sequence of greywacke, argillite, chert and conglomerate, with minor acid and basic volcanics, and a number of mafic and ultramafic intrusives, and (ii) a younger fossiliferous sequence, chiefly Upper Cambrian in age, which consists mainly of conglomerate, sandstone and siltstone and has a maximum thickness of about 1300 m on the Denison Range. The younger sequence is everywhere unconformable on the older rocks but is conformable and gradational with the Ordovician in most areas.

A thick unit of essentially non-marine conglomerate and sandstone occupies a transitional position between the fossiliferous Upper Cambrian and Lower Ordovician marine sequences, and is herein called the Reeds Conglomerate. This formation and its correlates, the Owen Conglomerate etc., have traditionally been included with the overlying marine Ordovician formations in the "Junee Group", largely because in many areas there is an unconformity between the conglomerate and the underlying Cambrian or Precambrian rocks. However, more recent work, including that on the Denison Range, has shown that the conglomerate is transitional to Upper Cambrian sediments in some areas, and that its palaeogeographic and tectonic affinities are as much with the geosynclinal Cambrian rocks as with the Ordovician shelf-type sequences. Despite this,

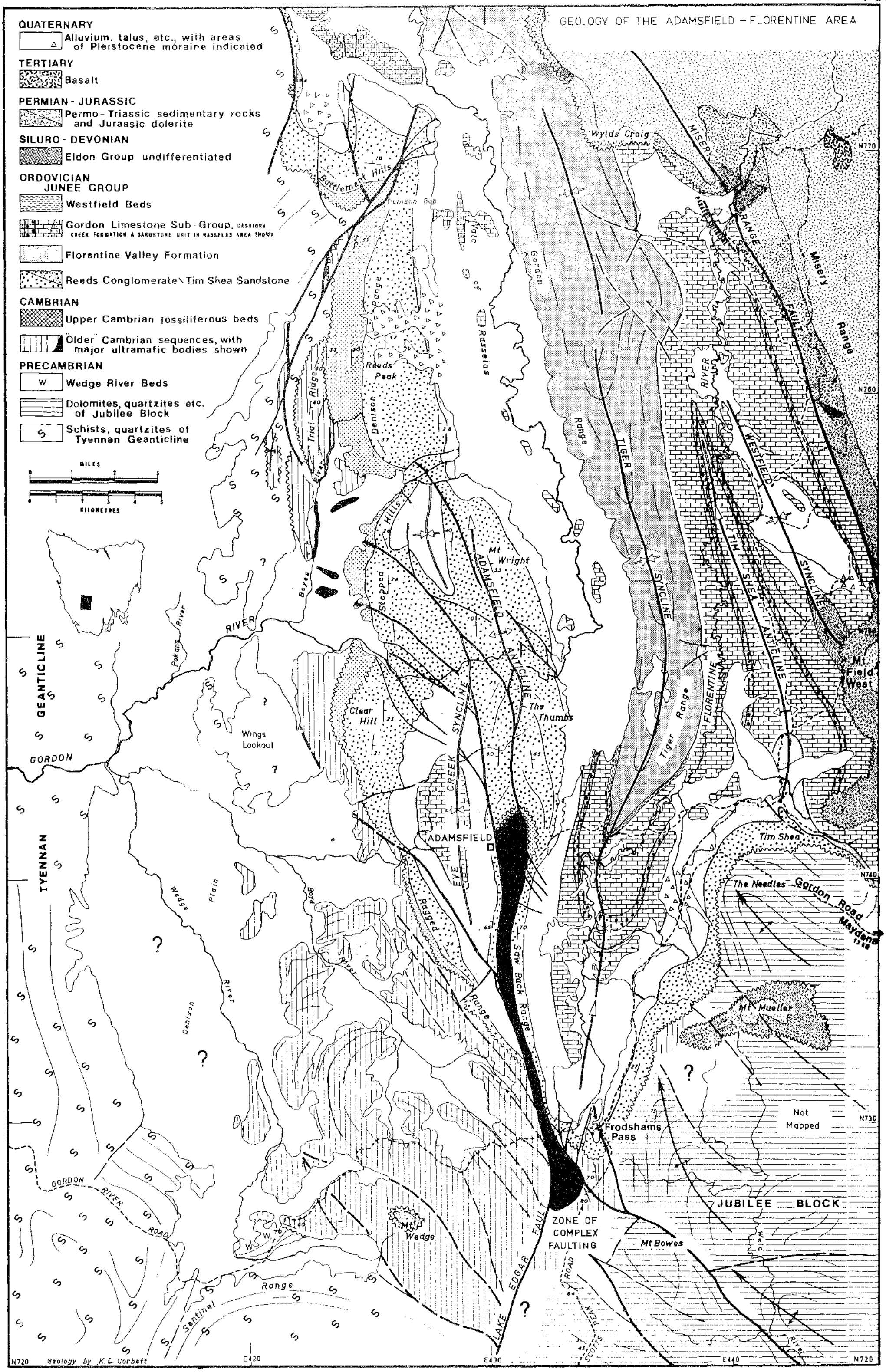

FIG. 1. - Geological map of the Florentine Synclinorium and environs (modified after Corbett 1970).

it appears preferable at this stage to retain the conglomerate within the Junee Group rather than isolate it as a separate unit or include it in a Cambrian group, since it extends geographically well beyond the limits of the Upper Cambrian sequences and overlaps unconformably onto older rocks, while retaining its conformity with the overlying formations.

The Ordovician marine succession, which consists largely of limestone, is discussed in detail in this paper. It passes conformably upwards into a thick sequence of sandstone and shale which comprises the Eldon Group and has generally been considered to be of Siluro-Devonian age. More recent work discussed in this paper indicates that the limestone-sandstone transition occurs in the Upper Ordovician.

The Parmeener Supergroup (Banks 1973) rests unconformably on the folded Ordovician - Devonian sequences, and except where affected by major faults, against which the beds may be dragged into a sub-vertical attitude (e.g. against the Misery Range Fault), tend to be sub-horizontal. Outliers of these rocks occur on Mt. Mueller and probably also on Mt. Wedge. Faulted sections are exposed in road cuttings along the Misery Range where the total thickness is of the order of 500 m. The Supergroup here includes Permian and Triassic rocks.

A thick sill of Jurassic dolerite overlies the Parmeener Supergroup, and caps most of the eastern peaks. The base of the sill is near the Permo-Triassic boundary along the Misery Range but transgresses steeply upwards at the southern end of Mt. Field West.

Pleistocene till-like deposits occur at Lawrence Rivulet, near The Needles - Tim Shea Saddle, on the valley floor west of The Needles, along the Denison Range and on the valley floor northwest of Battlement Hills. Glacifluvial gravels form an extensive blanket down the Rasselas Valley and also occur in the Florentine Valley, downstream of Lawrence Rivulet bridge. Tilted gravel and carbonaceous clay beds, possibly of Pleistocene or earlier age, are exposed on the Gordon Road one km east of the old Needles heliport. These and other high-level occurrences of alluvial deposits at about the 450 m (1500 ft) level possibly represent remnants of a valley floor formed when the Florentine River flowed west into the Gordon, prior to its capture by the Derwent (Jennings 1955; Corbett 1963).

A small area of Tertiary basalt is being quarried for road metal on Parker Road at the northern end of the Misery Range, and there is another small basalt area about two km northeast of this. The presence of the (?) plug of basalt mapped by Jennings (1955) near the old Benjamin settlement in the Florentine Valley has not been confirmed, and the basalt and dolerite float, and limonitic material, which occur in this area could be remnants of an old valley surface.

PREVIOUS STUDIES

Although the Ordovician succession in the Florentine area has figured prominently in discussions of Tasmanian stratigraphy for many decades, the area was not mapped in any detail until the senior author's work in 1963. Limestone was first reported from the area in 1850 (*Proc. R. Soc. V.D.L.* June 12, 1850) and later in the same year Akers reported siliceo-ferruginous conglomerate from the Great Bend of the Gordon River (*ibid.*, Dec. 12, 1850). Gould reported limestone in the area in 1861 (footnote). Some trilobites collected by T. Stephens from Tim Shea were described by Etheridge (1904), but little was known of the geology until Twelvetrees' exploration in 1908. He recognized the major synclinal structure of the area, assigning the limestones to the Lower Silurian (i.e. Ordovician) and the conglomerates of The Thumbs, Denison Range etc. to the Cambrian. Those at Tim Shea he called Permo-Carboniferous. Hills (1921) clarified the stratigraphic relations somewhat, and recognized the Silurian sandstone sequence of the Tiger and Gordon Range.

Nye's (1929) account of the osmiridium field at Adamsfield gave a reasonably accurate interpretation of the general structure and the relationships of the major formations, and included a useful sketch map of the area. He recognized the "Cambro-Ordovician" slates and cherts west of Adamsfield, and the unconformable relationship with the overlying conglomerates. He correlated these with the "West Coast Range Conglomerate Series", and the overlying limestone with the "Gordon River Limestone Series", then thought to be Silurian.

The work of Lewis (1940) in the Tim Shea - Maydena (Tyenna) area is important in that he proposed the "Junee Series", and, in conjunction with the palaeontological work of Kobayashi (1940), established its Ordovician age.

The next important work was that of Carey and Banks (1954) in which Lower Palaeozoic unconformities at Adamsfield and Tim Shea were described, with sketch maps showing the generalized structure and stratigraphy of these areas. They clarified the structural relations at The Needles, which had been mis-interpreted by Lewis (1940), and defined the Tyennan Unconformity between the conglomerate on Tim Shea and the underlying Precambrian dolomites. The unconformity on the serpentinite at Adamsfield was mis-interpreted, however, since the overlying rocks, which they correlated with the Owen Conglomerate, actually belong to an Upper Cambrian (Öpik, in Banks 1962 b, p. 137) sequence below the conglomerate.

The northern sections of the Florentine Valley and Gordon Range were mapped on a regional scale by I.B. Jennings (1955). Slight revision of some of this mapping has been necessary. Banks (1957) reviewed the state of knowledge of the Ordovician System to that date, summarizing the palaeontological contributions of Kobayashi (1940 a,b), Brown (1948), Öpik (1951), Teichert and Glenister (1953) and Banks and Johnston (1957) from the Florentine area, and listing some new fossils from the Gordon Limestone in the area. In a later, more comprehensive review, Banks (1962 a) redefined the Junee Group, Florentine Valley Mudstone, and Gordon Limestone in the Florentine area, and condensed new palaeontological data from Singleton (unpub. pers. comm.) and Thomas (1960).

The major part of the Florentine Valley was mapped in some detail by Corbett (1963). A significant result of this work was the first subdivision of the Gordon Limestone into six more or less mappable units. The revised stratigraphy of the limestones proposed herein is based on that work. In 1966-69 the major remaining part of the synclinorium was mapped, including the inaccessible Denison Range area (Corbett 1970). An appendix to that work included a revised Ordovician stratigraphy, upon which the present stratigraphy is based.

ORDOVICIAN TERMINOLOGY

Background

The terminology applied to the Tasmanian Ordovician rocks has been a matter of considerable confusion and debate since the rocks were first described in the latter part of the last century, and some anomalies still persist. Prior to about 1948 it was thought that there were probably two distinct conglomerate-sandstone-limestone sequences within the Lower Palaeozoic of the state, one being Cambrian or Ordovician, the other Silurian.

This arose from two basic errors. The first was made by Charles Gould (1862) when he correlated limestone near the mouth of the Gordon River and considered by him to be above the Eldon Group with limestone at the Great Bend (near The Thumbs). Limestones occur on many horizons near the mouth of the Gordon River, several in the Eldon Group (Gee *et al.* 1969) and one in the Junee Group. Gould himself corrected this mistake in 1866 and wrote of the Gordon Limestone as occupying the stratigraphic position now assigned to it and as being Lower Silurian (Ordovician in the modern sense). The second basic error arose when Etheridge (1896) assigned a Silurian age to a collection from rocks, including limestone, above conglomerates at Zeehan. He correctly recognized the Ordovician affinities of some fossils and the Devonian affinities of others but because the field stratigraphy by Montgomery in an admittedly very complex area was not good enough, assumed that the collection came from essentially one horizon and was therefore probably Silurian. The collection is now known to have come from both Junee and Eldon Groups. From this and subsequent events arose the concept that there were two sequences, conglomerate to limestone, in the Lower Palaeozoic. This development was fully summarized by Thomas (1948), who supported the concept.

Carey (1947) strongly opposed the two-sequence concept, and further field work established that the major formations were of Ordovician age and could be correlated throughout the state. Hills and Carey (1949) proposed the term "Junee Group" for this generalized sequence, following the work of Lewis (1940) in the Tyenna area, and defined it as consisting of five formations, viz. Jukes Breccia and correlates at the base, followed by West Coast Range Conglomerate, Caroline Creek Sandstones and Shales, Gordon River Limestone, and Crotty Sandstones at the top.

The Crotty Formation has since been shown to include Silurian beds and is now assigned to the Eldon Group, but the remainder of the succession, with only slight modification, is still quoted, and the "Junee Group" is still used in this way for some purposes. Thus Banks (1962 a, p. 147), in a review of the Ordovician, states: "The Ordovician rocks of Tasmania are known as the Junee Group, which may be defined as consisting of the following formations or their correlates: Fenestella Shale at the top, Gordon Limestone (Lower to Upper Ordovician), Florentine Valley Mudstone, Caroline Creek Sandstone, Owen Conglomerate, Jukes Breccia."

It should be noted that only two of the type formations (Gordon Limestone and Florentine Valley Mudstone) are from the type area of the "Junee Group" (i.e. Florentine - Maydena area), the others being from the west coast and north-western areas. The lack of a single complete Ordovician section in which all the formations were named and defined has been a major factor in the nomenclatural disagreements.

The Tasmanian Geological Survey has had to adopt a somewhat different policy with respect to Ordovician nomenclature in their regional mapping programme in recent years. Recognizing the variations in the formations, particularly the lower ones, and the fact that deposition of these units may not have been continuous either spatially or temporally from one area to another, there has been a tendency to use local names for formations and groups in each area or basin, e.g. Magog Group with Roland Conglomerate and Moina Sandstone, overlain by Gordon Limestone in the Sheffield area (Jennings 1963). (Banks 1962 a (fig. 13 and text) adopted this practice when dealing with conglomerates in the lower part of the Group). Thus Williams (in Jennings *et al.* 1967) regards the term "Junee Group" as applying only to the Florentine Valley sequence. It is appropriate at this stage to re-define the "Junee Group" in terms of the formations which are present in the Junee (now Maydena) area.

The recent mapping of the Florentine Synclinorium, which may be considered as including the type area of the original "Junee Series" of Lewis (1940), indicates that the Ordovician section in this area is more complete and probably better exposed than most of the other sections in Tasmania, and should thus provide a good basis for detailed correlation throughout the state. A new and expanded terminology is proposed which incorporates those elements of the old terminology which are still applicable.

Revised Terminology

In the revised terminology (fig. 2) the basal conglomerate of the Denison Range etc. is given formation status (Reeds Conglomerate), and the laterally-equivalent sandstone unit around the southern side of the synclinorium is made a separate formation (Tim Shea Sandstone). The reasons for this are given below. The overlying sequence of fossiliferous sandstone and siltstone is also given formation status (Florentine Valley Formation). Since the limestone is subdivisible, it is given subgroup status (Gordon Limestone Sub-group), the sub-group consisting of three formations

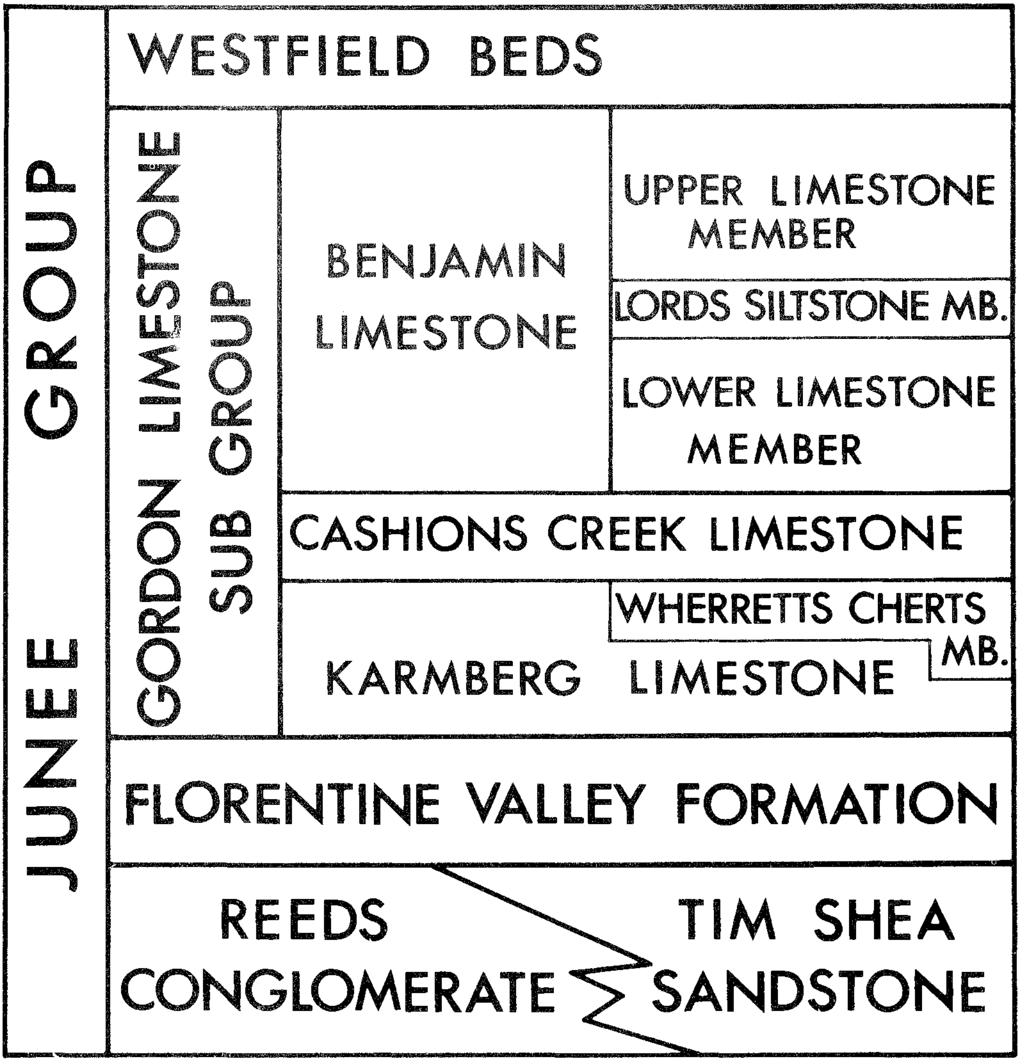

FIG. 2. - Revised terminology of Junee Group.

(Karmberg Limestone at base, Cashions Creek Limestone, Benjamin Limestone). A unit of chert-rich limestone is distinguished at the top of the Karmberg Limestone, and is called the Wherretts Chert Member. The Benjamin Limestone constitutes the bulk of the sequence, and in places can be subdivided into three members, viz. the Lower Limestone Member, the Lords Siltstone Member and the Upper Limestone Member. At the top of the Junee Group is placed the Westfield Beds, a sequence of siltstone and sandstone occupying a transitional position between the limestone and the overlying Eldon Group. The Westfield Beds - Eldon Group contact has not yet been clearly defined.

The decision to have two laterally equivalent formations at the base of the group was made because, although the term "Tim Shea Conglomerate" (Öpik 1951; Banks 1962 a) has precedence, it was considered that the section at Tim Shea was not typical of the formation elsewhere, and that there were sufficient lithological and palaeogeographic differences to warrant two formations being established. The Reeds Conglomerate consists typically of non-marine conglomerate, whereas the Tim Shea Sandstone consists mainly of marine and non-marine sandstones. The two formations appear to interfinger to some extent, but pending detailed mapping the contact between the two is taken as the fault at Frodsham's Pass (fig. 1).

A coarse, locally-derived breccia occurs in places beneath the Reeds Conglomerate and Tim Shea Sandstone, and is probably equivalent to the "Jukes Breccia" of other areas. It has not been given any formal status in this area, partly because it is not sufficiently continuous but also because it appears to be developed on a transgressive surface which continues below the Upper Cambrian sequence where the latter is developed.

DEFINITIVE AND DESCRIPTIVE STRATIGRAPHY

In this section the various rock units are described and defined according to the Australian Code of Stratigraphic Nomenclature, and preliminary palaeontological data are given.

Junee Group

Synonomy: Junee Series - Lewis 1940; Junee System - Carey 1947; Junee Group - Hills and Carey 1949; Banks 1962 a; Older terms are given by Banks (1962 a) and Smith (1957).
Derivation: The old township of Junee, now incorporated in Maydena.
Type area: Florentine Synclinorium, including Denison Range, Tim Shea and Florentine Valley sections.
Thickness: Maximum of the order of 4200 m (14000 ft) in the Denison Range - Rasselas Valley area.
Age and relationships: Upper Cambrian (probably) to Upper Ordovician; mostly conformable on Upper Cambrian sequences but otherwise unconformable on older rocks; apparently conformable and transitional with the Siluro-Devonian Eldon Group.
Elements: see fig. 2.

Reeds Conglomerate (nov.)

Definition: That formation of quartzose conglomerate and conglomeratic sandstone, usually red to purplish in colour, occurring on the crest and eastern slopes of the Denison Range. It has a maximum thickness of about 1560 m (5200 ft), and is laterally equivalent to the Tim Shea Sandstone. It transitionally overlies Upper Cambrian sediments on the Denison Range and adjacent areas, but is unconformable on Precambrian rocks west of Battlement Hills. It has an upper sandstone unit in most areas which is transitional with the sandstone at the base of the overlying Florentine Valley Formation; the base of that formation in such areas is taken as the first appearance of flat-bedded sandstone with worm burrows. It is named for Reeds Peak, highest point on the Denison Range, and may be largely Upper Cambrian in age.

Description: The Reeds Conglomerate is a mountain-forming unit of siliceous conglomerate which extends from the Battlement Hills in the north to the Saw Back Range in the south. It varies greatly in thickness, reaching a maximum of over 1500 m near Reeds Peak. It occurs essentially as four great wedges, one centred on Battlement Hills, one on the Denison Range, one in the Clear Hill - Thumbs - Stepped Hills area, and one at the Ragged Range - Saw Back Range (figs. 1, 3).

The contact with the Upper Cambrian sediments is conformable in most areas. The upper contact with the marine Florentine Valley Formation is transitional and probably interfingering. Intercalations of marine sandstone with abundant worm burrows occur in the middle part of the sequence at Clear Hill and The Thumbs. The top of the formation in most areas is a sandstone or conglomeratic sandstone unit, up to about 100 m thick, which varies from red to grey in colour and usually shows abundant trough cross-bedding.

The bulk of the formation is red to brown to purplish in colour, and consists of pebble to boulder grade siliceous conglomerate, with an abundant sandy matrix, interbedded with conglomeratic sandstone. Within the mega-wedges there appears to be a second-order arrangement of large lenses of conglomerate, up to 100 m or so thick, separated by sandstone (fig. 3). Third-order lensing on the scale of beds or groups of beds can be seen in most outcrops. The sandstones show abundant trough cross-bedding, while the finer conglomerates are characterized by abundant scour-and-fill structures, rapid interlensing of sand and gravel, rare large-scale tabular cross-bedding, and fairly numerous channel structures up to 10 m across. The coarse conglomerates tend to be thick bedded to massive, but large channel structures and large-scale heterogeneous cross-bedding occur in places. Imbrication of tabular clasts is apparent in a few sections.

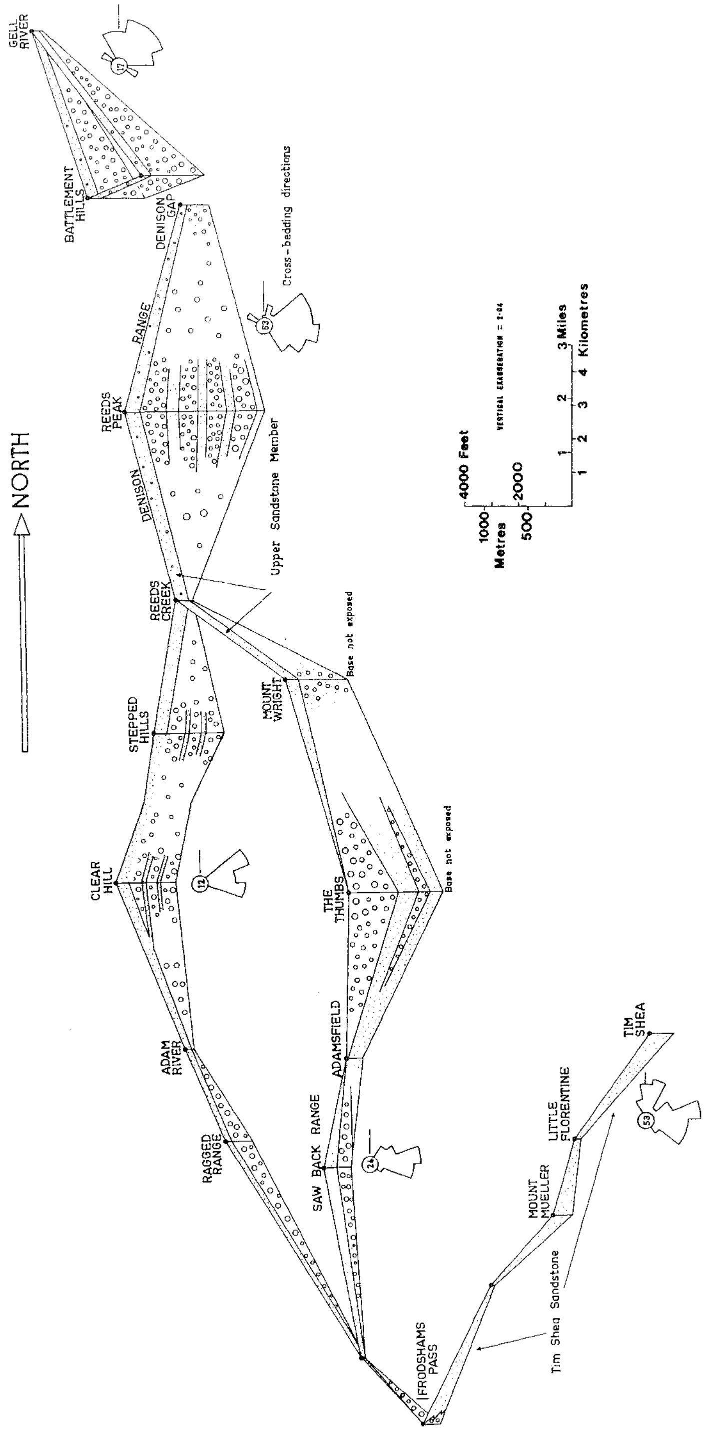

FIG. 3. - Block diagram showing distribution of Reeds Conglomerate and Tim Shea Sandstone. Cross-bedding measurements shown.

The majority of clasts consist

of either quartzite or quartz-schist, and the only other common types are vein quartz, chert and quartz sandstone. Igneous rock fragments are apparently absent, as is feldspar. Most of the clasts are well rounded to very well rounded, with moderate to high sphericity, while the sand-grade material is mostly sub-angular to sub-rounded. The bulk of the material appears to have been derived from the Precambrian rocks of the adjacent Tyennan Geanticline, with possibly a small contribution (mostly chert) from the Cambrian rocks in the southern part of the area. Palaeocurrent evidence to date also indicates derivation from the Tyennan Geanticline (fig. 3).

The prevailing red colour of the sediments, the abundance of cross-bedding and channel structures, the pronounced lateral variability of the sequence, the rounding and imbrication of the clasts, the bimodal nature of the conglomerates, the absence of very fine-grained material, and the absence of fauna except for worm burrows in the rare marine intercalations, indicate deposition by powerful streams under non-marine conditions. The features coincide closely with those of modern alluvial fan complexes on which deposition is mainly by shallow braided streams (e.g. Denny 1965; Bull 1963; McKee 1957; Blissenbach 1954; Gregory 1915; Trowbridge 1911), and with ancient deposits interpreted as fanglomerates of this type (e.g. Allen 1965; Bluck 1965; Potter 1955; Krynine 1950). There is little evidence to support their interpretation as littoral deposits as suggested by several authors (Twelvetrees 1903; Bradley 1954; Carey and Banks 1954), although there is interfingering with marine sandstone in places, indicating proximity to the shoreline. The formation and its equivalents in western and northwestern Tasmania (Owen Conglomerate etc.) would appear to be one of the most extensive and best developed examples of alluvial fan deposition in the geological record. Such an interpretation was first suggested by Hills (1915) and later supported by Banks (1962 a).

Tim Shea Sandstone

Definition: That formation of red to grey quartzose sandstone with minor conglomerate and red siltstone exposed on the crest and northern slopes of Tim Shea and on the cuesta ridges to the southwest. It has a locally derived breccia at the base in some areas, and at Tim Shea this rests unconformably on Precambrian dolomite. The thickness is variable, with a maximum of the order of 300 m (1000 ft) at Tim Shea. It is laterally equivalent to the Reeds Conglomerate, and conformable with the overlying Florentine Valley Formation. The presence of *Clonograptus rigidus* (Lancefieldian) in beds only a hundred metres or so above the top (Quilty 1971) at The Needles suggests the age may be largely Upper Cambrian. It is synonymous with the "Tim Shea Conglomerate" of Banks (1962 a, p. 160).

Description: This formation rests unconformably on the Precambrian rocks around the eastern flank of the synclinorium. It consists mainly of quartzose sandstone and conglomeratic sandstone with lesser pebble conglomerate and some basal breccia and chocolate shale in places. It shows considerable lateral variations in thickness (fig. 3).

The base of the formation at Tim Shea is a very irregular unconformity on the Precambrian dolomite (Tyennan Unconformity of Carey and Banks 1954), with at least one channel-like feature up to 60 m (200 ft) deep. The channel is filled with dolomitic breccia, and this is overlain by poorly exposed dolomitic sandstone followed by about 12 m (40 ft) of red shale containing abundant small tube-like structures. Rather similar red shales occur in the upper part of the Upper Cambrian sequence at Adamsfield and on the Ragged Range, and it is possible that those at Tim Shea are correlates of the Upper Cambrian sequences.

The main part of the formation consists of alternating zones, up to 100 m or so thick, of red cross-bedded sandstone and grey flat-bedded bioturbated sandstone. Red sandstone with abundant trough cross-bedding predominates at Tim Shea, but near Mt. Mueller the sequence is mostly grey. Poorly-preserved gastropods occur in grey sandstone near the base of the sequence in the latter area, and the grey horizons in all areas appear to be marine. The red association on the other hand, appears to be unfossiliferous and is probably non-marine. The presence of sub-angular chert fragments in many beds, and of disseminated chromite grains in some places, suggests partial derivation from Cambrian rocks, although the bulk of the material is of Precambrian derivation.

Fifty-three current directions measured at Tim Shea (fig. 3) show two pronounced modes at right angles, possibly reflecting both littoral and fluvial currents. The environment envisaged is a flat coastal plain at the seaward edge of the major alluvial fans of the Reeds Conglomerate, with shallow marine conditions alternating with alluvial floodplain deposition.

Florentine Valley Formation

Definition: That formation of sandstone and siltstone with lesser limestone and chert which conformably overlies the Tim Shea Sandstone and Reeds Conglomerate and underlies the Gordon Limestone Sub-group. It is best exposed on the Gordon Road north-west of The Needles, on the Florentine Road at The Gap, and in Squirrel Creek in the northern Rasselas Valley. It is about 450 m (1500 ft) thick in the Tim Shea area, and about 600 m (2000 ft) thick in the northern Rasselas area. It contains an abundant marine fauna dominated by brachiopods, trilobites and gastropods, and is Lower Ordovician in age. It encompasses the "Florentine Valley Mudstone" and "Caroline Creek Sandstone" of Banks (1962 a) as applied to this area.

Description: The formation consists of a mixture of quartzose and calcareous sandstones, micaceous and calcareous siltstones, impure nodular limestone, chert, and minor glauconitic shale, with marine fossils present on many horizons.

The base of the formation in most areas consists of coarse-grained pink to grey quartzose sandstone containing numerous worm casts and gastropods, usually exposed on the lower dip slopes of the ridges formed by the underlying formation. At Tim Shea these basal beds grade up into grey silty quartzite with interbedded siltstone, followed by thin-bedded siltstone with bands rich in fossils. Further west, on the Gordon Road, the basal rocks include white sandstone with worm casts and gastropods, and interbedded glauconitic shale. At the southern end of the Ragged Range, in a cutting on the Saw Back track to Adamsfield, a thin-bedded white quartzose sandstone near the base of the formation contains an abundant gastropod fauna, with forms similar to *Ophileta* sp. and *Raphistoma* spp.. In the Denison Range area the base is transitional with the upper sandstone unit of the Reeds Conglomerate, and consists of thick-bedded gritty sandstone grading up into thin-bedded white sandstone with abundant gastropods. Ripple marks, load casts and longitudinal furrow structures occur in the thin-bedded white sandstone at Battlement Hills.

The middle part of the formation in The Needles - Tim Shea area includes about 100 m of interbedded calcareous siltstone and impure nodular limestone. These are particularly well exposed in cuttings on the Gordon Road just northwest of The Needles (near the 12 mile peg). A similar unit occurs at The Gap and in the logging area at the end of 5 Road (fig. 4). This part of the sequence is richly fossiliferous, with brachiopods, trilobites, gastropods and dendroids. Quilty (1971) identified *Clonograptus rigidus* from this unit near The Needles, indicating a Lancefieldian age. The unit has not been identified west of The Needles or in the Saw Back Range - Thumbs area, but a similar unit occurs further north in the Denison Range - Battlement Hills area. Here it is of the order of 150 m thick and consists mainly of grey calcareous siltstone grading to nodular impure limestone, with lesser quartzose sandstone and micaceous siltstone. Weathering of the calcareous nodules in the limestone produces a yellowish clay and gives the rock a characteristic pock-marked appearance.

The upper part of the formation around Tim Shea consists of interbedded micaceous and calcareous siltstone, quartzose sandstone, impure limestone and chert. The chert forms a residual gravel capping on low ridges in places, and is used for road metal. This part of the sequence is exposed on the ridge traversed by 8 Road East (fig. 4), along 5 Road and the old HEC Road (fig. 4), and on the Gordon Road east of the Little

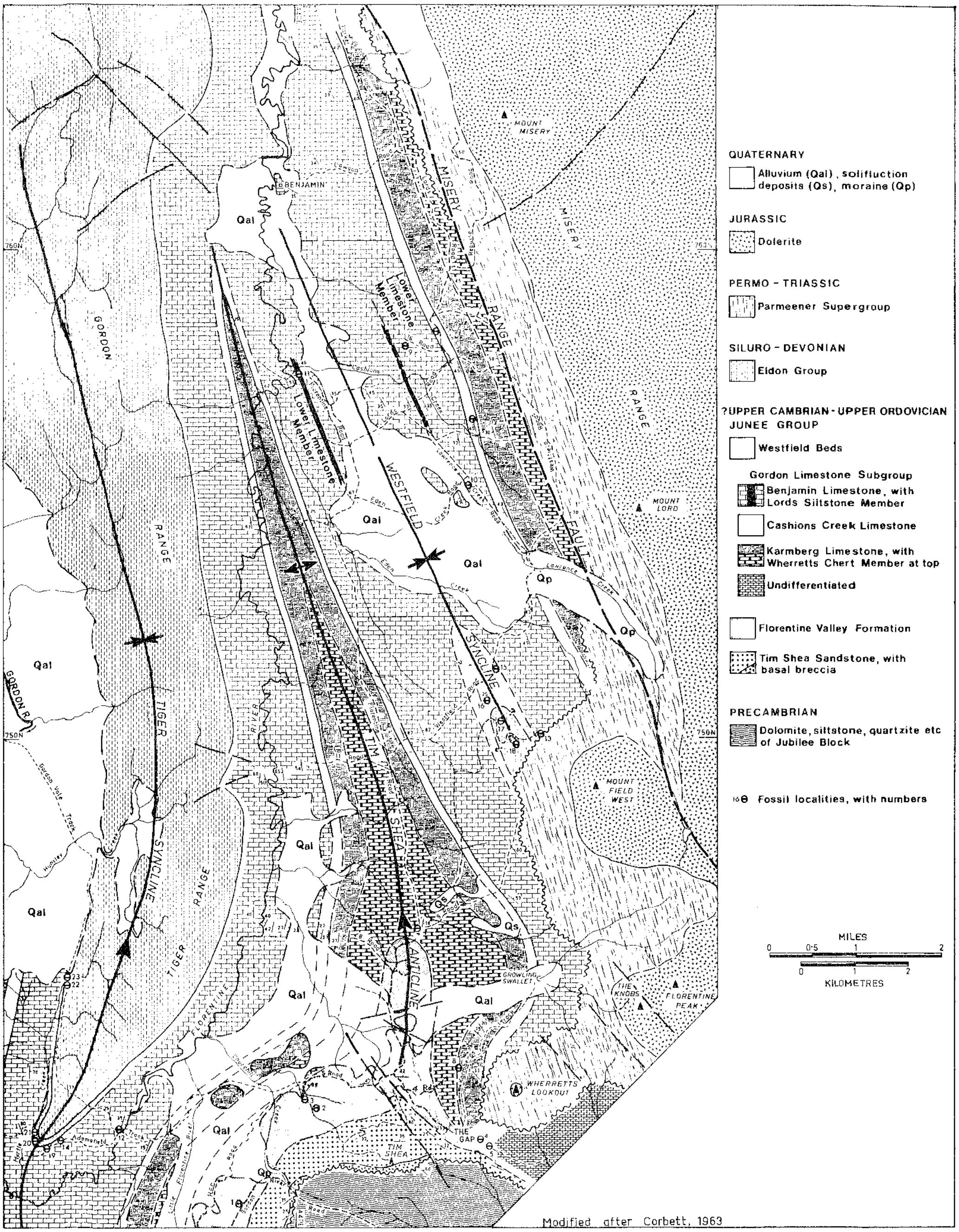

FIG. 4. - Geological map of the Florentine Valley (modified after Corbett 1963).

Florentine River. At The Gap, this part of the formation appears to be represented by the zone of interbedded siltstone and chert at the old gravel loading chute. A thin section of a chert band from here shows it to consist largely of monaxon sponge spicules (Corbett 1963). In the Denison Range area, the upper part of the formation forms a broad low ridge (Timbs Ridge) and consists of about 300 m of quartzose sandstone interbedded with siltstone and glauconitic sandstone. The sandstones show trough cross-bedding in places. North of Battlement Hills this unit forms a sharp-crested ridge and consists mainly of thinly-interbedded sandstone and siltstone showing ripple marks and wavy bedding. This unit is only sparsely fossiliferous in this area.

Palaeontology: The Florentine Valley Formation has a rich shelly fauna dominated by trilobites and brachiopods but including also worms, gastropods, bivalves, "cystoids", and rare beds of graptolites. The known occurrences may be summarized as below:

Localities	1	2	3	4	5	6
Taxa:						
Tritoechia lewisi				x	x	
T. cf. *planulata*			x			
? T. careyi			x	x		
cf. *Schmidtites*				x		
inarticulates	x					
Finkelnburgia cf. *bellatula*		x				
worms				x		
Nuculites (Cleidophorus)						
cf. *planulatus*			x			
Lecanospira tasmanensis				x		
Hystricurus cf. *genulatus*			x			
H. paragenulatus			x	x		
cf. *Parahystricurus* sp.			x			
Pseudohystricurus sp.				x		
"Asaphopsis" florentinensis						x
"Asaphopsis" juneensis			x	x		
Cybelopsis sp.			x	x		
Tasmanaspis lewisi			x			
cystoids				x		
Clonograptus rigidus	x					
Clonograptus sp.				x		
Tetragraptus sp.				x		
Didymograptus gracilis				x		
cf. *mundus*				x		
Tentaculites						x

Localities are:

1. Gordon Road at 12 mile post
2. 400 metres south of end of 5 Road
3. 5 Road (co-ordinates 440,400 E. 742,500 N)
4. Cuttings on A.N.M. road at The Gap
5. Currawong Gully (near The Gap)
6. Near The Gap (Etheridge 1904)

Locality 1 is close to the base of the formation and was considered Lancefieldian by Quilty (1971) and if the range given by Thomas (1960, p. 16) for *C. rigidus* applies, the rocks there may be correlated with La 2 or La 3 of the Victorian succession, and may thus be Late Tremadocian or Early Arenigian (Strachan 1972, pp. 11-12).

Localities 4, 5 and 6 are all close to the top of the formation and the graptolite fauna (*D. gracilis* and *D.* cf. *mundus*) suggests correlation with the Chewtonian or lower Castlemainian of Victoria and in turn an Arenigian age (Zone of *D. nitidus* or early part of *I. gibberulus* zone in Great Britain). These ages are supported by ages based on the brachiopods (Brown 1948) and trilobites (Singleton, in Banks 1962 a, p. 170), ages with which occurrence of hystricurids and *Cybelopsis* are also consistent. The *Cybelopsis* species is close to the species illustrated by Hinze (1952, pl. xxv, f. 1-4) but very much smaller. Closer correlations must await detailed study of the rich and well-preserved brachiopod and trilobite faunas.

Several associations may be recognized. On some bedding planes are intense concentrations of *Tritoechia* and orthids or of *Finkelnburgia*. Quilty (1971, p. 183) noted two other associations, one of inarticulate brachiopods such as *Westonia*, the other of very abundant dendroids. The dendroid-graptoloid association at The Gap has few other fossils in it but is not as rich in dendroids as that near the 12 mile post on the Gordon Road. Other beds contain almost exclusively trilobites, especially hystricurids (both in siltstone at The Gap and in sandstone on the Gordon Road), or "*Asaphopsis*". The "cystoids" usually occur as dispersed plates associated with trilobites but one specimen with plates in association has been found in siltstone at The Gap.

Gordon Limestone Sub-group

Definition: That sequence of marine limestone with lesser siltstone and sandstone lying conformably between the Florentine Valley Formation below and the Westfield Beds above. The type area may be taken as the southern Florentine Valley, where three formations are mappable (fig. 4), viz. Karmberg Limestone at base, Cashions Creek Limestone, and Benjamin Limestone. A composite stratigraphic section is shown in fig. 5. The thickness reaches a maximum of the order of 2100 m (7000 ft) in the northern Rasselas Valley, and is 1200 - 1800 m (4000 - 6000 ft) in the Florentine Valley. A thick sandstone unit occurs near the base of the sequence in the Battlement Hills area (fig. 1). The sub-group ranges in age from Lower to Upper Ordovician, and is synonymous with the "Gordon Limestone" of previous authors (e.g. Banks 1962 a).

Remarks: Because of their high solubility the Ordovician limestones characteristically form broad, flat-floored, poorly drained solution valleys usually covered with extensive superficial gravels. The Vale of Rasselas (fig. 1) is a typical example. The lack of outcrop under such conditions usually makes stratigraphy difficult or impossible. Exposure is better than normal in the Florentine Valley because the old drainage pattern has been disrupted by river capture, and the present Florentine River and tributaries have dissected much of the limestone surface and removed much of the superficial cover.

The major units mapped by Corbett (1963) in the Florentine have since been traced into the southern part of the Vale of Rasselas (Myrtle Creek drainage area), but over most of this valley there is very little outcrop except in stream beds. A thick sequence of coarse quartzose sandstone forms a low ridge on the valley floor north of Battlement Hills, and it is apparent that much of the lower half of the sequence is non-calcareous in this area. A narrower continuation of this sandstone ridge extends south down the main part of the Vale of Rasselas.

Karmberg Limestone (nov.)

Definition: That formation of impure limestone and chert-rich limestone lying between the Florentine Valley Formation below and the Cashions Creek Limestone above. Best exposures are on the lower northern slopes of Wherrett's Lookout and along 9 Road from its junction with the main Florentine Road (fig. 4), but no single complete type section is yet known. It is of the order of 450 m (1500 ft) thick, and possibly ranges in age from Upper Canadian to Chazyan (fig. 5). It is named for Karmberg's Track, an old track leading from The Gap around the eastern side of the valley. The upper 150 m or so consists of chert-rich limestone in the Florentine area, and is designated the Wherrett's Chert Member. The proportion of chert apparently decreases markedly to the west, however, and the member is not recognizable in the southern Rasselas area.

Description: The lower part of the formation consists mainly of impure nodular limestone and calcareous siltstone such as exposed at 9 Road junction, and is richly fossiliferous in places. Large spherulites of pyrite, commonly oxidized to limonite, occur within this rock and may be found scattered over the surface in places. The correlate of this part of the sequence west of Adamsfield contains an Upper Canadian cephalopod fauna. The upper part of the formation is poorly fossiliferous and constitutes the Wherretts Chert Member.

Palaeontology: The fauna at the 9 Road junction (loc. 7) is rich in a new plectambonitid species, and trilobites including agnostids, *Geragnostus* and *Trinodus*, *Cybelopsis* and other pliomerids, *Tasmanocephalus stephensi*, and a new species close to *Platillaenus*. Several ostracodes including *Eoleperditia*, a "cystoid" close to *Leptocystis* and rare graptolites, *Phyllograptus anna*, *P. ilicifolius* also have been recognized. Although some taxa present in the underlying Florentine Valley Formation were still present, new ones had appeared. *Phyllograptus ilicifolius* occurs in the Chewtonian of Victoria (Thomas 1960) and a form close to *P. anna* in the *G. austrodentatus* zone of the Darriwillian (Harris 1935). *P. anna* also occurs in the Pitman Formation in Canberra in beds regarded by Opik (1958, pp. 15, 86) as Darriwillian. The two species occur together also in the Garden City Formation and Phi Kappa Formations in the Basin Ranges (Ross and Berry 1963, pp. 81-83) within the Zones of *Tetragraptus fruticosus* and *D. protobifidus* considered by Ross and Berry as late Arenigian. Thus in the terms of Berry (1968, p. 24) it is Late Canadian and of Cassinian age (Whittington 1968, p. 51). The lithological correlation with the cephalopod bearing beds at Adamsfield mentioned above is supported by the palaeontological evidence as Teichert and Glenister (1953, p. 9) regarded the Adamsfield fauna also as Upper Canadian.

Wherretts Chert Member (nov.)
Definition: That unit of dark grey limestone, containing up to 50% chert, occurring on the lower northwestern slopes of Wherretts Lookout and forming low ridges capped with chert gravel around the southern Florentine Valley (fig. 4). It is about 180 m thick and probably of Chazyan age.

Description: This member forms cliffs and steep slopes east of 4 and 6 Roads, but elsewhere its presence is mainly indicated by low strike ridges covered with residual chert gravel. The ridges carry a distinctive vegetation and hence the unit is a good mapping horizon. The chert gravel is quarried for road metal in several places, e.g. the Westfield Road turnoff. The chert occurs mostly as very irregular beds up to 15 cm thick, but irregular lenses, patches and nodules are also common. The percentage of chert varies between beds from 5% to 50%, with 10 - 20% being about average. The proportion of chert decreases upwards.

Palaeontology: Fossils occur in this member, usually silicified internal and external moulds. They are not, however, common, and few have been collected. Just north of Wherretts Lookout (loc. 8) *Nybyoceras* cf. *paucicubiculatum* has been identified, suggesting (after Teichert and Glenister 1953, p. 13) a Champlainian age.

Cashions Creek Limestone (nov.)
Definition: That formation of thick-bedded dolomitic limestone containing abundant *Girvanella* colonies which forms a prominent strike ridge in many areas and is well exposed where Cashions Creek is crossed by an easterly branch road from Lawrence Creek Road, and for several miles north of this (fig. 4). It is of the order of 150 m (500 ft) thick and is probably of Chazyan age (fig. 5).

Description: This formation crops out more strongly than any other unit within the limestone sequence, probably because the high proportion of dolomite renders it less soluble and the thick bedding makes it less prone to disintegration. Small subspherical colonies of *Girvanella* occur in profusion throughout most of the unit, and

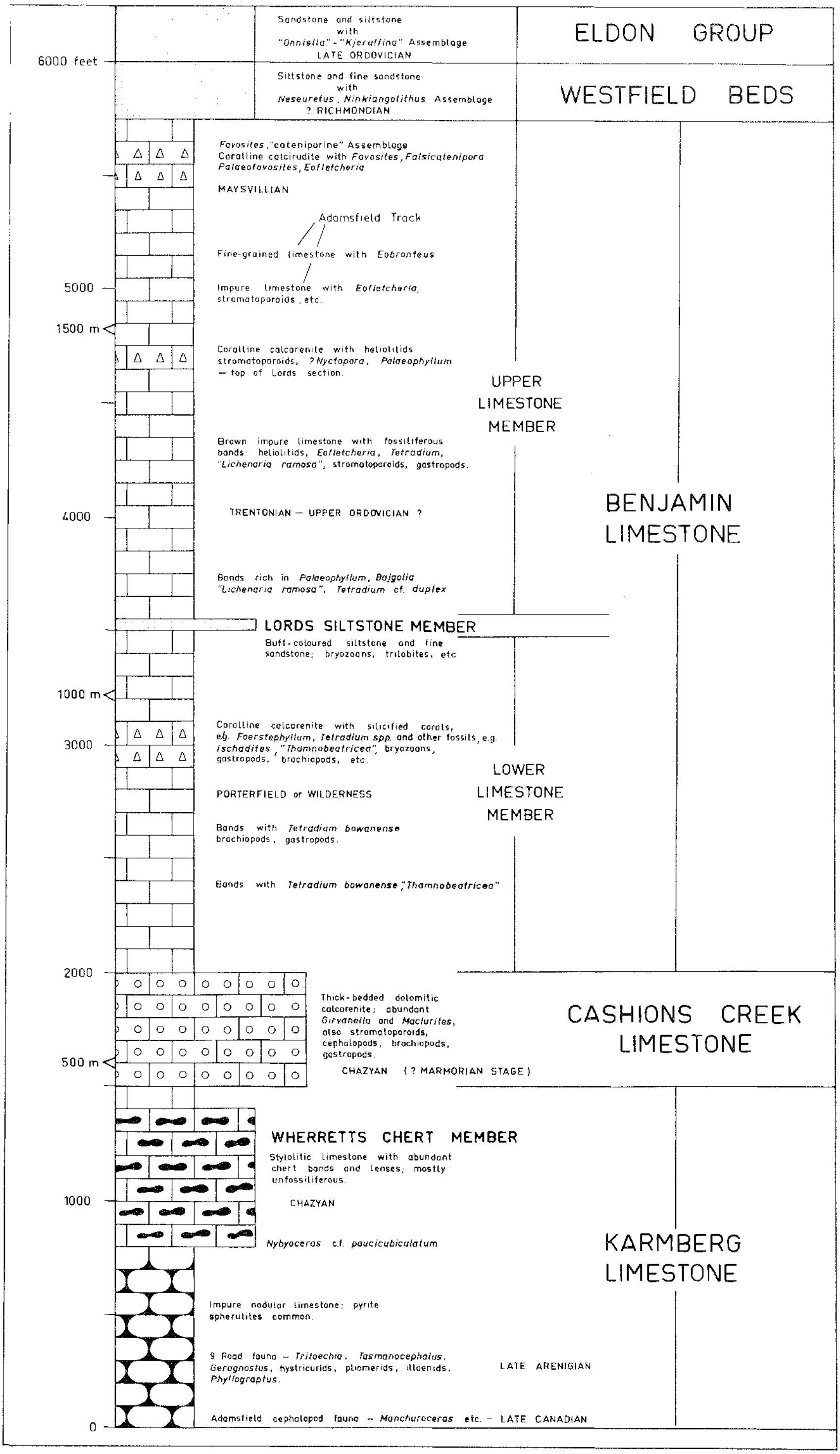

FIG. 5. - Composite section of Gordon Limestone Sub-Group and Westfield Beds.

the large flat-bottomed gastropod *Maclurites* is a common associate. The rock is mostly a fine calcarenite, non-stylolitic, and weathers to an off-white colour. The formation forms a discontinuous, low strike ridge, a section of which can be traced almost continuously from Cashions Creek to a point several kilometres north of Dawson Road (fig. 4).

Palaeontology: The fauna is dominated by *Girvanella* spp. and *Maclurites florentinensis*, but a stromatoporoid close to *Stromatocerium rugosum*, strophomenid brachiopods, rare illaenids and some cephalopods, *Orthonybyoceras tasmaniense*, also occur. The *Maclurites* species is closest to *M. magnus* from the Marmor Stage (Cooper 1956).

Benjamin Limestone (nov.)
Definition: That formation of limestone and minor siltstone lying between the Cashions Creek Limestone below and the siltstones and sandstones of the Westfield Beds above (fig. 4). No single complete type section is yet known, but the formation is well exposed in the area between the old Benjamin Settlement and the lower slopes of Mt. Field West (fig. 4). It is of the order of 900 - 1200 m (3000 - 4000 ft) thick and probably ranges in age from Middle to Upper Ordovician (fig. 5). The Lords Siltstone Member divides the unit into two parts which for convenience are called the Lower Limestone Member and the Upper Limestone Member.

Lower Limestone Member: This is of the order of 480 m (1600 ft) thick, and in 1963 was best exposed immediately west of the Cashions Creek Limestone in the vicinity of 16 Road (fig. 4). Rapid variations in lithology, particularly in the dolomite content and in the number and form of stylolites, is characteristic. Most of the lower half consists of unfossiliferous stylolitic and dolomitic limestone, with fossils occurring in narrow, isolated bands. Beds of brown to black limonitic limestone occur in places, and there are several thin horizons of chert nodules. The limestone varies from micrite to very coarse calcarenite, but the fine-grained types predominate. Most of the limestone is considered to be sub-standard for economic purposes. Thin horizons rich in *Tetradium* cf. *bowanense* occur in a number of places, with *"Thamnobeatricia"* also present in some.

The most distinctive horizon is a 45 metre (150 ft) unit of thick-bedded, richly fossiliferous crinoidal calcarenite which occurs about 330 m above the base, and forms a narrow strike ridge fronted by low cliffs just west of the end of 16 Road (loc. 9). The rock is characterized by the presence of numerous large silicified colonies of a tabulate coral similar to *Foerstephyllum halli*, and other corals, stromatoporoids, sponges, cephalopods, brachiopods, gastropods and *"Thamnobeatricia"* also occur. This unit is exposed again about 100 m southwest of the junction of Eden Creek Road and Lawrence Creek Road (loc. 10). The rock is composed largely of fossil fragments and dolomite.

Palaeontology: The fauna from the known fossiliferous horizons is dominated by sessile benthos such as the dasycladacean *Ischadites* (*"Receptaculites"* of earlier reports), stromatoporoids comparable to *Thamnobeatricia*, rugose corals such as *Foerstephyllum* close to *F. halli* and tabulates, predominantly chaetetids. These last include a *Lichenaria* close to *ramosa* and another species of *Lichenaria*, and several species of *Tetradium*, e.g. *T. bowanense*, *T. dendroides*, *T.* cf. *duplex T. (?) cruciforme* Webby & Semeniuk, *T. apertum* Webby & Semeniuk, *T. compactum*, *T. ? cribriforme* and *Billingsaria* is also present. Other taxa recognized include *Solenopora*, large diameter colonies of *Girvanella*, *? Acidolites* and *Trochiscolithus*, orthid brachiopods, gastropods, *Ctenodonta*, *Hecatoceras longinquum* and a trilobite close to *Bumastus*, this last in a crinoidal biocalcarenite. The faunal association suggests deposition on a shallow floor beneath a clear sea and the crinoidal biocalcarenite indicates more competent currents than were present at most times during deposition of this unit. The overall aspect of the fauna is Champlainian but more detailed palaeontological work is necessary. The *Tetradium* association suggests correlation with Fauna 1 of Webby & Semeniuk (1971) of Gisbornian age (i.e. approximately Costerfield or Wilderness, Webby 1969).

Lords Siltstone Member (nov.)
Definition: That unit of buff-coloured micaceous siltstone and fine sandstone, about 15 m (50 ft) thick, exposed on the main Florentine Road 200 m east of the Florentine River bridge (fig. 4). It is probably of Middle Ordovician age, and is named for Lords Road (fig. 4).

Description: This member is generally poorly exposed, and could not be traced for more than about 3 km from the type area. A small outcrop of siltstone on a track connecting Lords Road to a branch road from Florentine Road to the north-west is considered to represent this member on the eastern limb of the Westfield Syncline (fig. 4). The unit has not been seen on the western limb of the Tim Shea Anticline. It is fossiliferous in the type area (loc. 11) and contains numerous bryozoans as well as trilobites, brachiopods, cystoids and ostracodes.

Palaeontology: Stictoporellids form the commonest element in this fauna, but being preserved only as moulds, are not readily identifiable. A phylloporine is also commonly present. Brachiopods and trilobites are approximately equally abundant and form the rest of the fauna. Both orthid and rhynchonellid brachiopods occur but identification has not proceeded further. The trilobites are particularly characteristic and include *Homotelus* sp., an ogygiocaridine, a form close to *"Asaphellus" lewisi*, fragments of a form tentatively identified as *Ampyx*, *Pliomerina* and another pliomerid, *Ectenotus*, and a trilobite of the *Tetralichas* group within *Amphilichas*. An ostracode close to *Eoleperditia* and beyrichiids are also present.

The characteristic fossils are the stictoporellids and *Pliomerina*. The overall aspect of the fauna is Champlainian and perhaps early Trentonian.

Upper Limestone Member: This unit is probably of the order of 600 - 700 m (2000 - 2500 ft) thick, but no single complete section between the underlying and overlying siltstone units has yet been found. Most of the unit was exposed in the core of the Westfield Syncline in the triangle between the northern end of Cashions Creek, Lords Road and the Florentine Road (fig. 4) in 1963, but the area may be heavily overgrown now. The upper part of the formation is exposed near the base of the Permian at the southern end of the Westfield Syncline, about 500 m southeast of the large sandstone quarry, and also near the Adamsfield Track at the southern end of the Tiger Range.

The lithology is very variable, with many dolomitic and stylolitic horizons and at least six zones of very impure brownish-black limonitic limestone. Fossils appear to be more common and more evenly distributed than in the lower member, but again there is a marked concentration into zones, particularly of the corals. Zones with *Bajgolia* and *"Lichenaria ramosa"*, are common towards the base, with stromatoporoids, cephalopods, gastropods, brachiopods and other small corals, also present. The white-weathering corals are distinctive against the brown-weathering limestone in many places.

Near the top of the Lords section is a distinctive zone about 18 m thick of fossiliferous limestone rich in corals, particularly a heliolitid, a form like *Nyctopora*, and a stromatoporoid. *Bajgolia* and other corals, as well as many gastropods, brachiopods and a few cephalopods, are also present.

Within a hundred metres of the top of the member at the southern ends of the Westfield and Tiger Synclines (Banks 1957) is a richly fossiliferous horizon with a characteristic fauna dominated by halysitids, *Favosites*, *Palaeofavosites*, *Eofletcheria* and stromatoporoids, with other corals, brachiopods, trilobites, and cephalopods also present.

Palaeontology: Horizons low in the Upper Limestone Member contain corals which also occur in the Lower Limestone Member such as *Lichenaria* cf. *ramosa*, *Tetradium* cf. *duplex* and *Foerstephyllum* but also contain others not known from the Lower Member, e.g. *Palaeophyllum* and *Bajgolia ida*. *Tetradium*, as a form of the *syringoporoides* group, probably *T. duplex* Webby & Semeniuk, extends further up the succession but the genus is not yet recognized from the uppermost horizon. Other corals from within the Upper Limestone Member include *Palaeophyllum* cf. *rugosum*, *Hillophyllum*, *Billingsaria*, ? *Acidolites*, ? *Propora*, *Plasmoporella* and *Eofletcheria contigua*.

Near the top of the Upper Member is a micrite containing *Eobronteus* (loc. 12).

The uppermost and richly coralline horizon contains an *Aulacera* species up to 5 cm in diameter, also recognised at The Den, Mole Creek, *Palaeophyllum ? crassum*, Webby, *Favistina*, ? *Calapoecia*, ? *Acidolites*, *Propora*, favositids, *Eofletcheria* and halysitids near the road metal quarry at the southern end of the Westfield Syncline. Trepostomes and a cephalopod probably *Beloitoceras* also occur at this locality (loc. 13). In the same horizon at the southern end of the Tiger Range (loc. 14) occur *Solenopora*, a stromatoporoid like *Clathrodictyon*, *Favistina* cf. *stellata* Hall, and other species of *Favistina*, *Cyathophylloides*, *Favosites* sp., *Palaeofavosites* sp., *Eofletcheria subparallela* and *E. irregularis*, and *Falsicatenipora chillagoensis* (Etheridge). The generic composition of this uppermost fauna is more like that of Webby's (1972, p. 150) fauna IV than older faunas especially in containing favositids and cateniporines. Fauna IV was thought (Webby 1972, p. 150) to be Bolindian and the occurrence of *Falsicatenipora chillagoensis* in the Gordon Limestone was assigned a similar age by Webby and Semeniuk (1969). This places it as Maysvillian or Richmondian as noted by these authors. The presence of *Diploepora* in correlates of the horizon at Mole Creek might suggest correlation with the uppermost Ordovician of Estonia (Porkuni Beds) but the example of a Middle Ordovician *Halysites* in New South Wales (Webby and Semeniuk 1969) prompts caution.

Recent identification by C.F. Burrett of conodonts from the uppermost limestone beds at the southern end of the Westfield Syncline, in the beds containing *Aulacera*, favositids and cateniporines suggest that they are no younger than Early Maysvillian.

Burrett (pers. comm.) reports that "The conodont fauna is lacking in diversity, consisting mainly of panderoitids and *Belodina compressa* and *Phragmodus undatus*. The problematical phosphatic helmet-shaped objects, covered in regularly disposed nodes (very similar to those described by Ethington and Clark, 1965, from the Lower Ordovician of Alberta) are twice as abundant as the conodonts. Scolecodonts are rare. Crinoid columnals are present. Apart from one gigantic conodont the fauna is diminutive.

The large conodont compares very closely with *Cyrtoniodus sinclairi* which is found in Faunas 11 and 12 of Sweet *et al.* (1971). The multi-element species *Belodina compressa* does not range above Lower Maysvillian in the U.S.A. (= lower part of Fauna II). The form species *Phragmodus undatus* is not very common and this ranges from Fauna 8 to Fauna 12 (i.e. Upper Blackriveran - Richmondian).

An obvious absentee is *Bryantodina abrupta* which occurs abundantly at Mole Creek (in its correct relative position) but does not occur in this sample. This ranges up to the top of Fauna 10 (Edenian) in the U.S.A., as do fibrous conodonts which are also abundant at Mole Creek.

This fauna compares most closely with that from the top of the Mole Creek section, and with Fauna 11 in the U.S.A. An Edenian - Early Maysvillian age is suggested."

The *Favosites*-cateniporine fauna recognized in the Florentine Valley in both the Westfield and Tiger Synclines is widespread in Tasmania, having been noted on Bubbs Hill, in the Olga - Hardwood Saddle, and in the Mole Creek Synclinorium. Despite the richness in corals the uppermost limestone in the Florentine Valley and elsewhere is not biohermal as far as is known. The corals, some of them colonies over 50 cm in diameter, are rolled and fragmented, and none have yet been seen in growth position.

Westfield Beds

Definition: That unit of buff-coloured siltstone and fine sandstone, with some coarse sandstone, exposed on the Westfield Road about 2½ km east of the Florentine Road, in the core of the Westfield Syncline (fig. 4). Sandstone which may belong to this unit, or to the overlying Eldon Group, is exposed in a large road metal quarry on the ridge south of Westfield Road (fig. 4). The base of the unit has not been seen, and its upper contact with the Eldon Group is not yet clearly defined. The unit is also exposed on the Adamsfield Track 100 m southeast of the Myrtle Creek bridge, and on the bombardier track just north of this. The thickness of the unit has not yet been determined, but is probably of the order of 150 metres. Its age is Upper Ordovician.

Description: Thin-bedded micaceous siltstone and quartzose fine sandstone are poorly exposed in road cuttings from about 300 m east of the sassafras landing on Westfield Road, and on branch roads and tracks in this area. The sequence becomes coarser-grained upwards, and quartzose sandstone and partly silicified buff-coloured sandstone are well exposed in the large gravel quarry at the top of the ridge south of Westfield Road. The rocks are fossiliferous on many horizons, with bryozoans, pelecypods, small brachiopods, trilobites and crinoid columnals being present in the siltstones, while large brachiopods are common in the sandstones, as well as rare trilobites and solitary corals.

Palaeontology: Within the Westfield Beds there are some richly fossiliferous horizons. Near the base on Westfield Road (loc. 15) siltstones contain trepostomes, stictoporellids, *Lepidocyclas*, *Pterinea* cf. *demissa*, *Neseuretus* cf. *birmanicus*, and other trilobites and ostracodes. Somewhat further up in the succession just west of the axis of the Westfield Syncline (loc. 16), are siltstones with inarticulate brachiopods, *Orthodesma*, *Pterinea*, a ctenodont, ? *Bumastus*, *Neseuretus* and *Ninkiangolithus*. A graptolite, possible *Glossograptus*, is also present at locality 16. The close similarity of the *Pterinea* to an Upper Ordovician (Richmondian) species from North America, the presence of *Neseuretus* and of *Ninkiangolithus* all support an Ordovician age for the faunas. Some of the species present are similar to Richmondian forms and such an age would be consistent with the stratigraphic position of the Westfield Beds.

Eldon Group

Above the siltstone and fine sandstones of the Westfield Beds and in and near the road metal quarry in the axial region of the Westfield Syncline are rather coarser sandstones which also include interbedded fine sandstones and siltstones. These higher rather coarser beds occur not only in the Westfield Syncline but also around the southern end of the Tiger Range. The finer beds have quite well preserved moulds, especially of brachiopods, but also of other fossils.

Palaeontology: The coarse beds in road cuts below the quarry contain simple cuneiform corals of several sorts, perhaps belonging to *Dalmanophyllum* and *Holophragma*, and poorly preserved brachiopods close to *Onniella* and *Kjerulfina*. In road cuttings on the eastern side of the quarry and in the quarry itself (loc. 18) are beds replete with trepostomes and rich in brachiopods close to "*Onniella*" and *Kjerulfina* but also containing some *Encrinurus* and other trilobites.

"*Onniella*" also occurs in all the fossil localities shown in the Westfield Beds and the basal Eldon Group on the Tiger Range (loc. 19 - 23).

The generic composition of the faunas suggests an Upper Ordovician rather than a Silurian age for these localities and it is likely that the Ordovician - Silurian boundary occurs further up in the Eldon Group on the Tiger Range.

GENERAL FAUNAL SUCCESSION

A gastropod fauna from the Ragged Range may be the oldest fauna in the Junee Group but its age is uncertain. The oldest recognized Ordovician fauna, that with

Clonograptus rigidus, occurs not far above the base of the Florentine Valley Formation and is Lancefieldian (Late Tremadocian or Early Arenigian) in age. The next highest fauna is that with *Finkelnburgia* and this is followed by a very rich *Tritoechia*, *Hystricurus*, *"Asaphopsis"* fauna which continues almost to the top of the formation. The hystricurid fauna of the Florentine Valley Mudstone suggests correlation with the Datsonian Stage of Jones *et al.* (1971) in Queensland. At the very top of the formation is the graptolite fauna at The Gap with *Clonograptus*, *Tetragraptus* and *Didymograptus* of Arenigian age.

The graptolite fauna is followed by beds which at Adamsfield contain a *Piloceras* - *Manchuroceras* fauna not yet recognized in the Florentine Valley but probably a little older than or coeval with the plectambonitid fauna including *Phyllograptus* species at the 9 Road Junction. This latter fauna is Late Arenigian.

A relatively unfossiliferous interval follows but one which does contain *Nybyoceras* cf. *paucicubiculatum*, a species recorded by Teichert and Glenister (1953) from beds at the base of the Gordon Limestone at Railton.

The next fauna is very rich in numbers and is dominated by *Maclurites*, *Girvanella* and *Stromatocerium* and is probably Marmorian.

Above the *Maclurites* beds are limestones with many species of *Tetradium*, with *Foerstephyllum*, *Ischadites*, *"Thamnobeatricea"*, *Lichenaria* and many other fossils. This fauna correlates well with faunas of Gisbornian age in New South Wales.

Limestone deposition was later interrupted by an influx of silt which supported a fauna containing stictoporellids and *Pliomerina* as the commonest elements.

Above the siltstone *Palaeophyllum* and *Bajgolia* enter the coralline faunas which higher in the succession lose *Lichenaria* and *Tetradium*. After these genera disappeared from the area, *Eobronteus* entered and flourished for a short time. Later again, probably late in the Edenian or early in the Maysvillian, *Favistina*, *Plasmoporella*, favositids and cateniporines such as *Falsicatenipora* entered or developed in the area. Later influx of silt probably caused the migration or destruction of the fauna of colonial corals and the fauna in the silt is dominated by brachiopods and trilobites, the latter including *Neseuretus* and *Ninkiangolithus*. This fauna is Upper Ordovician, perhaps Richmondian.

Higher in the succession is a trepostome - dalmanellid strophomenid fauna containing *"Onniella"*, cf. *Kjerulfina* and *Encrinurus*, probably also Late Ordovician.

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ILLUSTRATIONS OF THE ORDOVICIAN FAUNA OF THE FLORENTINE SYNCLINORIUM

PLATE 1

Figs 1-9.
Brachiopods from the Florentine Valley Formation; Early Ordovician; locality 2 (text-fig. 4), 400 m south of the end of 5 Road.
Figs 1-7,9,10: *Finkelnburgia* cf. *bellatula*.
1: rubber cast of interior of pedicle valve (UTGD 81302), x 2.
2: rubber cast of exterior of pedicle valve, counterpart of UTGD 81302 (UTGD 81307), x 2.
3,4: rubber cast (x2), and internal mould of pedicle valve (x1) (UTGD 81306).
5: internal mould of brachial valve, with internal mould of brachial valve of *Apheoorthis* sp. (UTGD 81303), x 2.
6: internal moulds, pedicle and brachial valves (UTGD 81304), x 2.
7: internal moulds of pedicle and brachial valves (UTGD 81305), x 2.
9: rubber cast of pedicle valve interior, with external and internal cast of *Apheoorthis* sp. (UTGD 81306), x 2.
10: internal mould, brachial valve, original of fig. 1., x 1.

Fig 8: *Apheoorthis* sp., internal cast of pedicle valve (UTGD 81305), x 2.

Figs 11-16, 18-27.
Brachiopods and trilobites from the Florentine Valley Formation, Early Ordovician; locality 3 (text-fig. 4).
11: *?Nanorthis* sp., internal mould of pedicle valves (UTGD 80998), x 2.
12: *Nanorthis* cf. *hamburgensis*, internal moulds of both valves, with hypostoma, probably of *"Asaphopsis" juneensis* (UTGD 80977), x 2.
13: *Nuculites (Cleidophorus)* cf. *planulatus* (UTGD 81053), x 5.
14,15: *"Asaphopsis" juneensis*, pygidia (UTGD 80993), x 1: (UTGD 80992), x 2.
16: *Hystricurus paragenulatus*, distorted external mould of a cranidium (UTGD 81056), x 2.
18: *"Asaphopsis" juneensis*, small cranidia (UTGD 81007), x 2.
19: librigenae of hystricurids (UTGD 81037), x 1.
20: *Hystricurus paragenulatus*, internal mould of cranidium (UTGD 81046), x 2.
21: *Hystricurus* sp., internal mould of cranidium (UTGD 81063), x 2.
22: *"Asaphopsis" juneensis*, distorted cranidium (UTGD 81015), x 1.
23: *"A." juneensis*, ventral surface of librigenae (UTGD 81001), x 1½.
24: hypostoma, probably of *"A." juneensis* (UTGD 80979), x 2.
25: *Hystricurus*, cranidium (UTGD 81055), x 1.
26: *Hystricurus*, librigena (UTGD 81061), x 1.
27: *Hystricurus*, cranidium (UTGD 81052), x 2.

Fig 17.
Trilobite, Florentine Valley Formation, Early Ordovician; The Gap (loc. 4, text-fig. 4).
17: *"Asaphopsis" juneensis*, distorted cranidium and broken pygidium (UTGD 81093), x 1.

Numbers UTGD ..... refer to specimens in the collection of the Department of Geology, University of Tasmania.

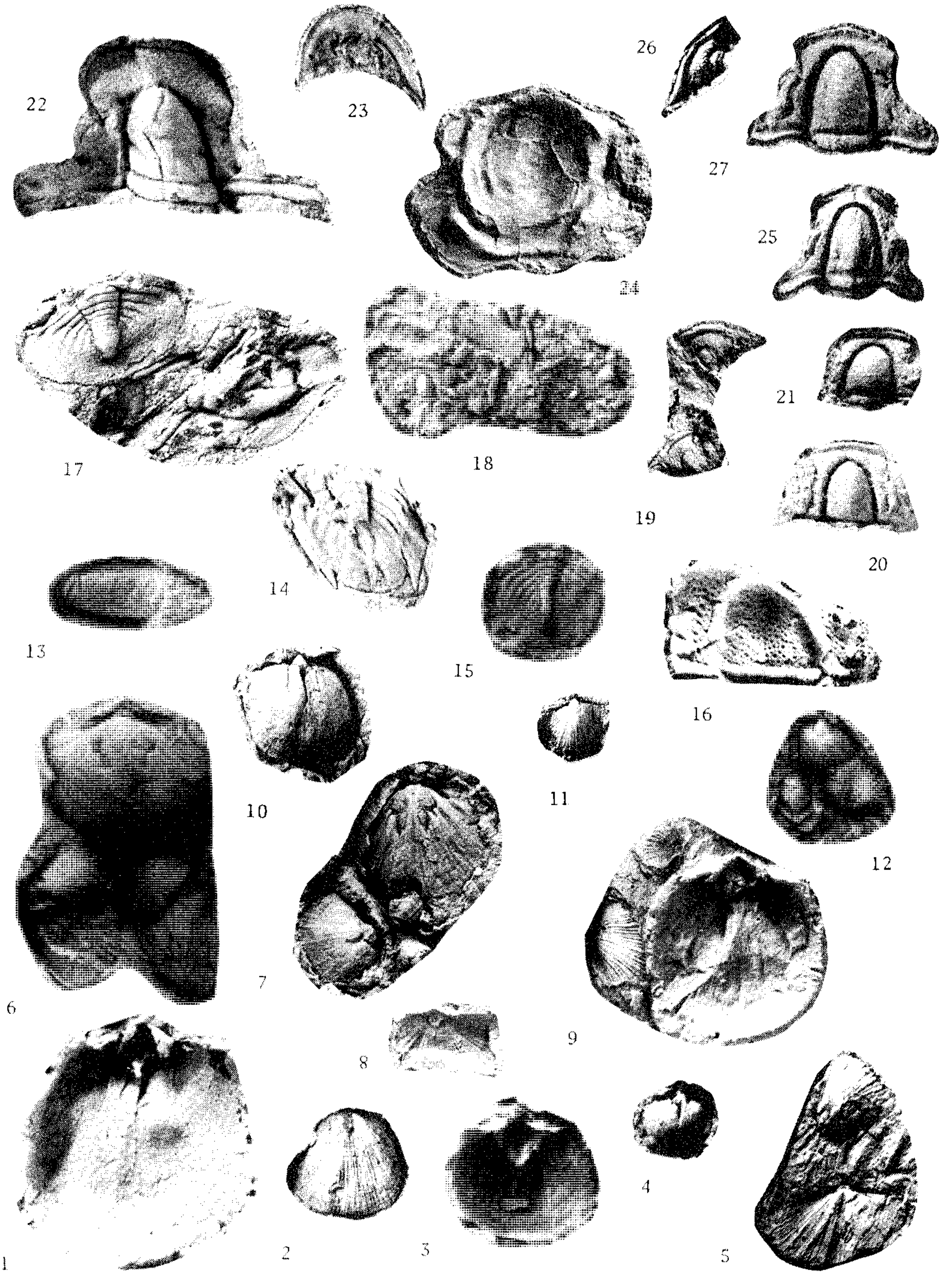


PLATE 1.

PLATE 2

Figs 1-16.

Brachiopods, gastropod, trilobites from the Florentine Valley Formation, Early Ordovician; The Gap (loc. 4, text-fig. 4); see also Plate 1, fig. 17.

1: *Nanorthis* sp., internal moulds of pedicle and brachial valves (UTGD 81110), x 2.
2: *Nanorthis* sp, internal mould of brachial valve (UTGD 81110), x 2.
3: *Apheoorthis* cf. *meeki*, internal mould of brachial valve (UTGD 81117), x 2.
4: *Apheoorthis* cf. *emmonsi*, internal mould of pedicle valve (UTGD 81117), x 2.
5: *Nanorthis* sp, and other brachiopods (UTGD 81110), x 2.
6(?)*Tritoechia careyi*, internal mould of brachial valve (UTGD 81092), x 2.
7-8: *Lecanospira tasmanensis*; 7: Z152 Tasm. Mus., x1 approx.; 8: rubber cast from Z152, x 1.
9: *"Asaphopsis" juneensis*, pygidium (UTGD 81074), x 1.
10: *"Asaphellus" lewisi*, pygidium (UTGD 81116) x 4/5 approx.
11: *Hystricurus paragenulatus*, distorted cranidium (UTGD 81106), x 2.
12: *Hystricurus* sp., pygidium (UTGD 81113), x 1.
13: cf. *Schmidtites* (UTGD 81117), x 2.
14: *Hystricurus* cf. *paragenulatus*, external mould of cranidium, (UTGD 81093), x 1.
15: *Cybelopsis* sp. and "cystoid" plate (UTGD 81073), x 5.
16: *Cybelopsis* sp., partial cranidium (UTGD 81085), x 2.

Figs 17-24.

Brachiopods, trilobites, cystoid, graptolite from the Karmberg Limestone; Early Ordovician; 9 Road junction (loc. 7, text-fig. 4).

17: cf. *Platillaenus* sp., and *Tasmanocephalus stephensi*, part of librigenae (UTGD 81287), x 2.
18: *Phyllograptus anna* (UTGD 81335), x 2.
19: *Tasmanocephalus stephensi*, external mould of cranidium (UTGD 81329), x 1.
20: *Trinodus* sp., pygidium (UTGD 81319), x 10.
21-23: *Spanodonta* cf. *hoskingiae*, internal moulds of pedicle valves (21, 22 - UTGD 81333), and brachial valve (23 - UTGD 81331), all x 2.
24: "cystoid" plate (UTGD 81284), x 2.
25: cf. *Eoleperditia* (UTGD 81333), x 5 approx.

Fig. 26.

Cephalopod, Wherretts Chert Member, Early Odovician; loc. 8 (text-fig. 4), just north of Wherretts Lookout.

26: *Nybyoceras* cf. *paucicubiculatum* (UTGD 81137), x ½.

Figs 27-8.

Gastropod, Cashions Creek Limestone, Marmorian.

27: *Maclurites, florentinensis*, section showing flat base and depressed apex (UTGD 25033), x ½; Cashions Creek.
28: *M. florentinensis*, view of base (UTGD 21718), x ½; near The Settlement.

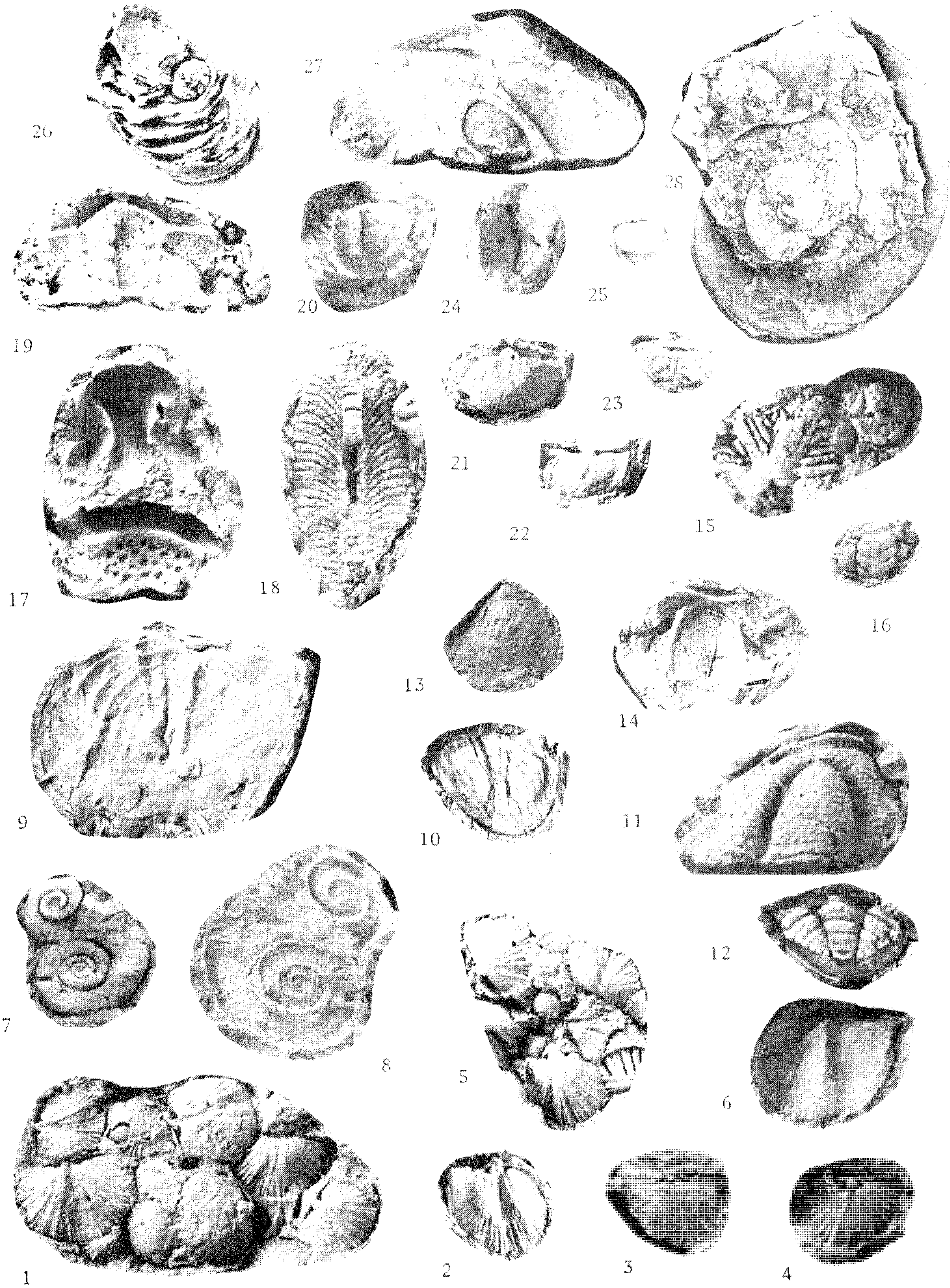


PLATE 2.

PLATE 3

Figs 1-4.

Stromatoporoid, tabulates and trilobite; Lower Limestone Member of the Benjamin Limestone, Mesial Ordovician; figs 1-3 - loc. 9 (text-fig. 4), near end of 16 Road; fig. 4 - near location of Eden Creek Road and Lawrence Creek Road.

1: *Tetradium apertum* (UTGD 81660), x 1.
2: cf. *Thamnobeatricia* (UTGD 81494), x 1.
3: *Tetradium tenue* (UTGD 81655), x 1.
4: *Bumastus* sp. (UTGD 81248), x 2.

Figs 5-17.

Polyzoa, trilobites, and echinoderm; Lords Siltstone Member of the Benjamin Limestone, (?) Early Trentonian; type section, Florentine Road.

5: *(?) Stictoporella* sp. and an encrinurid trilobite (UTGD 81340), x 2.
6: *Ectenotus*, pygidium (UTGD 81357), x 3.
7: *Camarocystites*, external mould (UTGD 81356), x 2.
8-11: *Pliomerina* cf. *sulcatifrons*, pygidia and cranidia; 8: UTGD 81338, x 5; 9: UTGD 81345, x 2; 10: UTGD 81340, x 2; 11: UTGD 81359, x 2.
12: *(?) Homotelus* sp., thorax and pygidium (UTGD 81347), x 1.
13-14: *Amphilichas (Tetralichas)*, internal mould of cranidium and part of counterpart thereof (UTGD 81272, UTGD 81271), x 2 approx.
15: phylloporine cryptostome (UTGD 81274), x 2.
16: *(?) Ampyx* sp., partly broken cranidium (UTGD 81353), x 2.
17: *(?) Stictoporella* and a trepostome (UTGD 81351), x 3.

Figs 18-21.

Corals and trilobites, Upper Limestone Member of Benjamin Limestone, Late Ordovician.

18: *Hillophyllum* sp. (UTGD 81316), x 2; locality north of Lords Road.
19: *Billingsaria* sp. (UTGD 81129), x 5; in *Eobronteus* bed, on Adamsfield Track about one km west of bridge over Florentine River (loc. 12, text-fig. 4).
20-21: *Eobronteus* sp, pygidium and cranidium (UTGD 81136, x 2; UTGD 81124, x 1); locality and horizon as fig. 19.

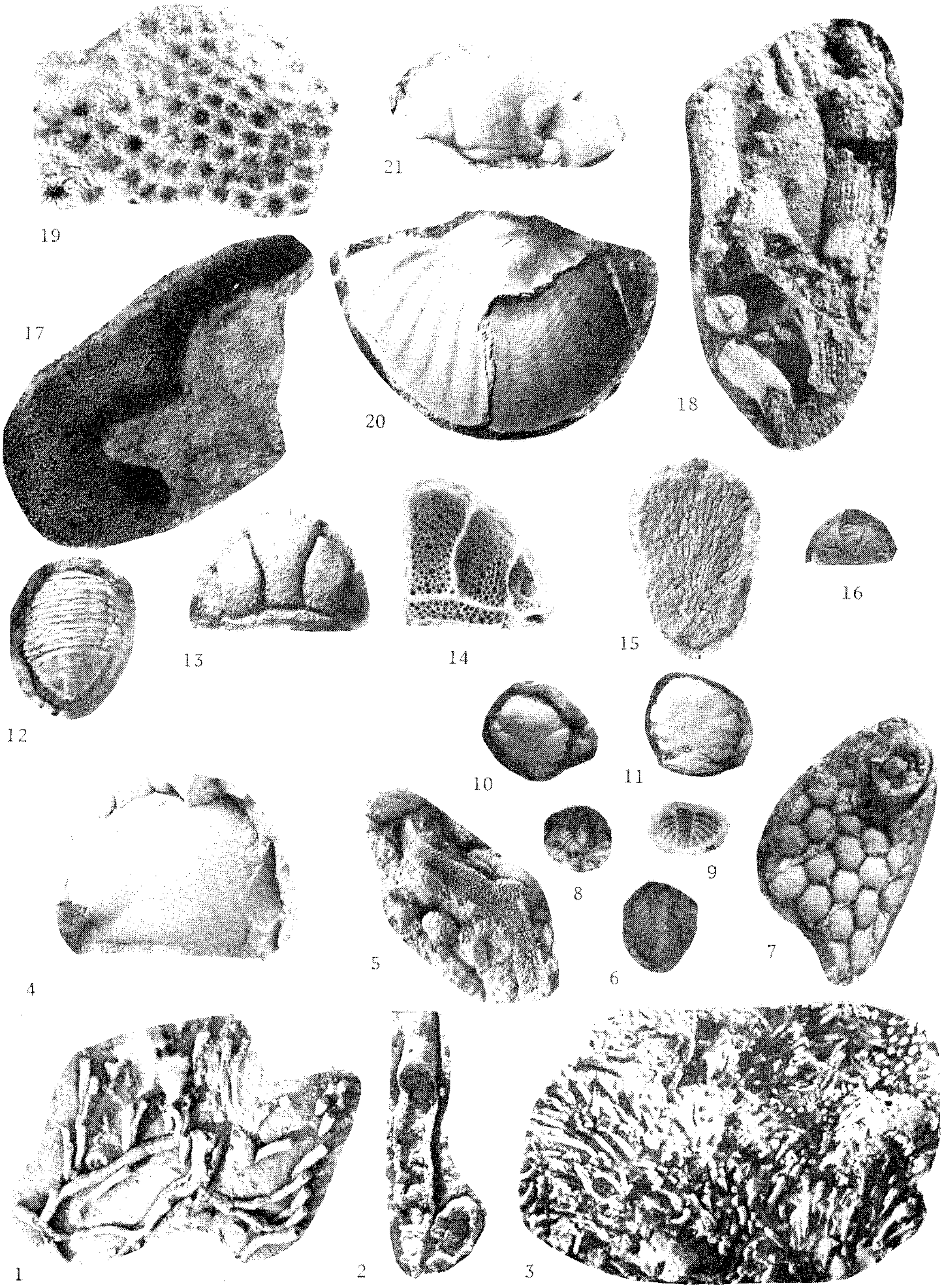
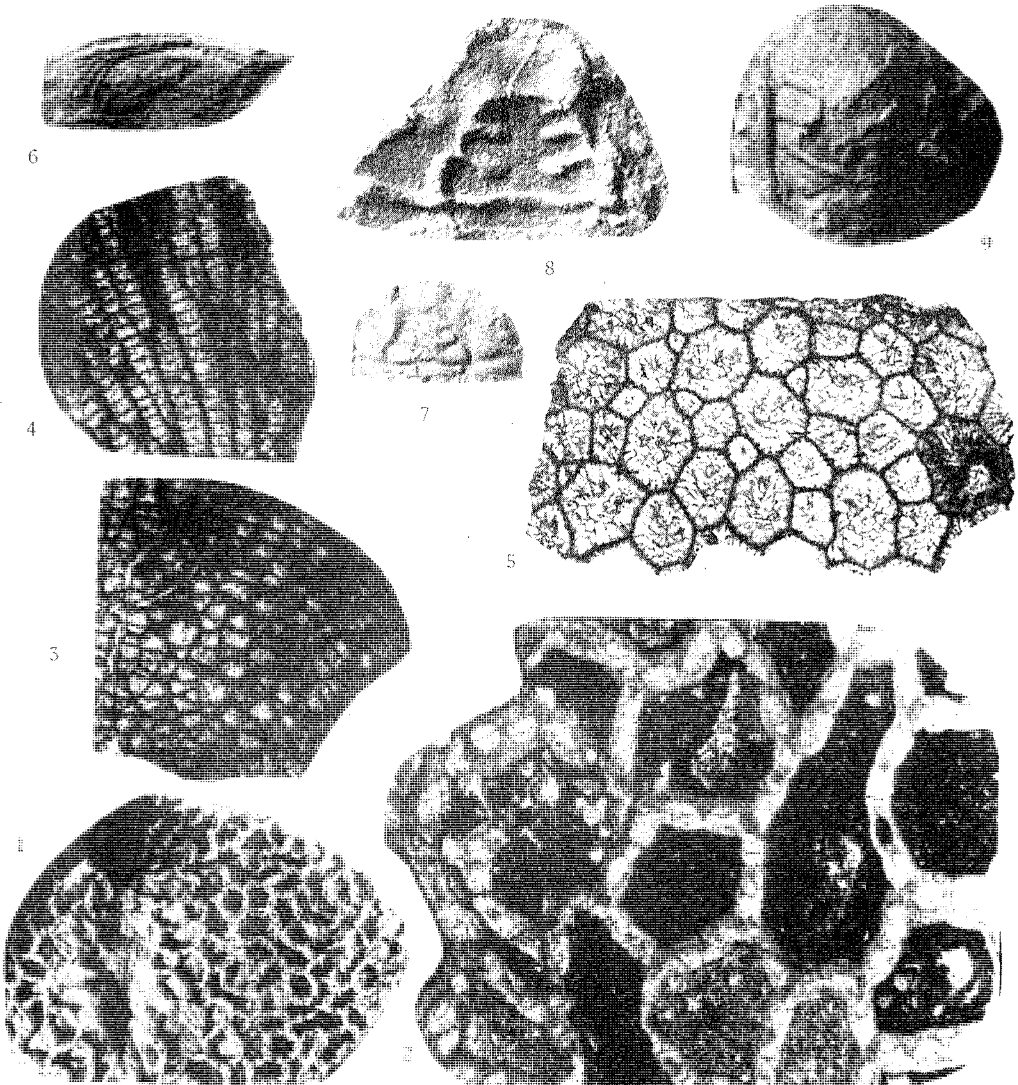


PLATE 3.



Figs 1-5.

Corals and trilobite from coralline horizon at top of Upper Limestone Member, Benjamin Limestone, Late Ordovician; loc. 14 (text-fig. 4), except Fig. 1.

1: *Falsicatenipora* sp., (UTGD 81483), x 1; The Den, Mole Creek.

2: *Falsicatenipora chillagoensis* (UTGD 22078), x 2.

3-4: *Palaeofavosites* sp., (UTGD 22150), x 2½.

5: *Favistina* sp., (UTGD 22136), x 2.

Figs 6-8.

Trilobites, Westfield Beds, Late Ordovician.

6: *Ninkiangolithus* sp., (UTGD 81399), x 4; loc. 16 (text-fig. 4).

7-8: *Neseuretus* cf. *birmanicus*, internal and external moulds of cranidia (UTGD 81374, x 2; UTGD 81378, x 4); loc. 15 (text-fig. 4).

Fig 9.

Trilobite, coralline horizon at top of Upper Limestone Member, Benjamin Limestone, loc. 14 (text-fig. 4).

9: *Ceraurinus* sp., cranidium (UTGD 22110), x 2.

PLATE 4.